OmniLift^{TM} Littoral Heavy Lift System Design

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Summary
Global port infrastructure is inadequate to meet the simultaneous demands across shipping, offshore energy (wind, hydrocarbon, and hydrogen), maritime defence, and marine vessel new build and maintenance for both the commercial and private sectors. Space within existing ports and capital for investment are limited resources. Successful life cycle operation of offshore energy generation facilities requires optimizing capital expenditures and real estate within ports by designing infrastructure projects capable of supporting maritime economic activity across many marine economic sectors over decades of operation. The OmniLift^{TM} System is designed to support life cycle operation of all of these vital marine industries. This paper presents the schematic design of OmniLift Systems for concrete or steel floating wind foundations as well as other heavy lift applications.

Keywords: offshore wind, ports, infrastructure, energy

Introduction

Global energy production is changing to address the effects of carbon emissions on the climate. Every country with coastlines bordering major bodies of water is in some stage of planning or actively replacing fossil fuel generation with marine-based wind power generation and hydrogen production. Simultaneously decommissioning and recycling legacy marine hydrocarbon energy production systems requires a littoral heavy lift system capable of efficiently launching and retrieving large structures.

This systemic change in energy production is driving the need for investment in port infrastructure to enable deployment of offshore wind energy production infrastructure and provide support for future operations and maintenance of these assets. Currently, this transition is focused on shallow-water fixed-base structures supported on monopiles and jacket structures. In 5 to 10 years this market will expand to include offshore floating wind generation. Eventually, thousands of these devices will be operating along coastlines globally, generating the gigawatts of electricity needed to power modern industrial economies.

All of this development will occur from repurposed port facilities, many of which are currently engaged in legacy energy production and maritime trade. Efficient planning of multi-use port facilities is essential to securing the success of this economic transition. Most importantly, well-designed port infrastructure projects will support the entire life cycle of offshore energy production and provide regional economic benefits and employment over many decades.

New types of heavy lift equipment that can support a variety of maritime industries are required. These systems must support industrialized production and maintenance of steel and concrete floating wind foundations, commercial and military vessel maintenance and decommissioning activities. They must use available space efficiently and avoid negatively impacting ongoing port operations and vessel traffic.

Figure 1 Life cycle solutions are required to support high volume projects.

Floating Wind Foundation Types

Floating wind foundations are constructed from either steel or concrete material. Steel floating wind foundations are larger in footprint, 90 to 105m square. The weight of these devices ranges from a low of 6,000 tons to 10,000 tons or more.

Concrete floating wind foundations are popular for countries where steel production and fabrication capacity are limited. These foundations come in many shapes and are smaller in footprint, 60 to 80m square. The weight of these foundations ranges from 18,000 tons to 28,000 tons.

OmniLift^{TM} Systems for Steel Foundations

OmniLift^{TM} Systems for steel foundations feature larger platform dimensions and lower lift station capacities. Platform dimensions range from 90 to 105m square. Lift station capacities from 500 tons to 800 tons are typical, depending on foundation geometry.

The OmniLift^{TM} system is unique in that it is the only littoral heavy lift system designed to lift and lower fully integrated floating foundations including; tower, nacelle and blades. This capability greatly reduces operational risks associated with integrating the generation equipment on a floating platform that is constantly in motion. More importantly the tide and weather window for integration is expanded as the foundation remains stable on the platform during the assembly process. As many as 5% of installed floating wind generation foundations will require major repairs annually, this means 3 to 4 units per Megawatt of offshore generation capability. Performing major repairs on the generation assembly at sea is a high risk undertaking that can only be managed in optimal weather conditions. Major repairs to a foundation at sea are not feasible. Towing these assemblies back to the implementation facility is safe and effective. Damaged generation equipment including blades and nacelle can be exchanged with replacement components allowing the device to be quickly returned to service.

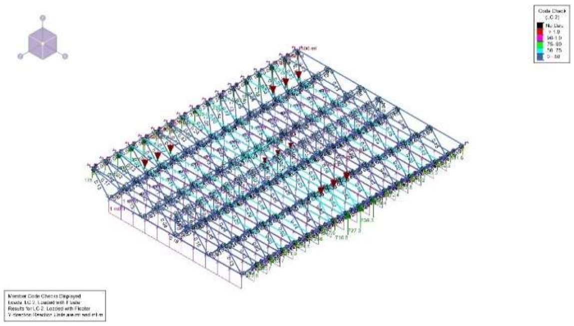

Figure 2 FEA Model of OmniLift™ with fully integrated foundation.

OmniLift™ Systems for Concrete Foundations

OmniLift™ Systems for concrete foundations have smaller platform dimensions and higher lift station capacities. Platform dimensions range from 60 to 80m square. Some concrete foundations are rectangular in plan and utilize cylindrical concrete ballast tanks for buoyancy, the platform is matched to the foundation footprint. Lift station capacities from 1,200 tons to 1,500 tons are typical, depending on foundation geometry.

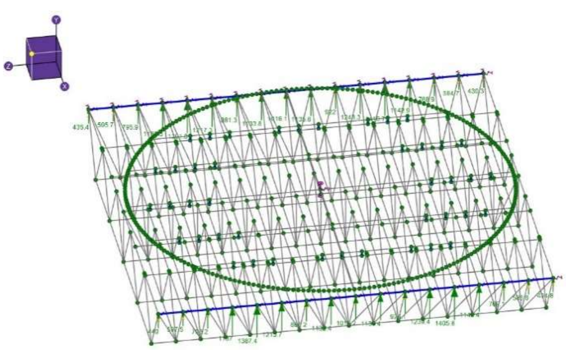

Figure 3 FEA Model of OmniLift™ with 28,000 ton Concrete Floating Wind Foundation.

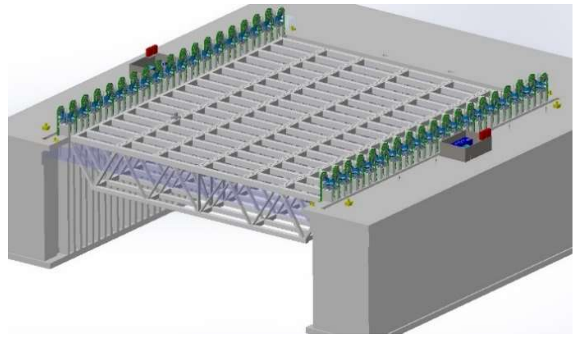

Figure 3 Model of OmniLift™ for launching and retrieving concrete floating wind foundations.

Integration of Existing Technologies

OmniLift™ Systems are a combination of existing proven technologies. These systems combine long span steel trusses with hydraulic chain jacks to produce a lifting system with capacities far beyond what was previously considered possible. Long span steel trusses are a proven structural design that has been in continuous use in onshore and offshore applications for well over a century. The hydraulic chain jack was first developed in the 1960’s for marine heavy lift applications. These devices have proven to be reliable, there has never been a failure of chain jack during operation.

The OmniLift™ concept is derived from long span truss lift bridges. The system can be thought of as a series of truss bridge lift spans connected to reliable and powerful hydraulic lifting mechanisms.

OmniLift™ systems utilize modern feedback motion control valves. This technology is widely used to precisely control heavy industrial manufacturing equipment. The OmniLift system chain jack operation is synchronized to within 1mm of precision, the tolerance limit of the linear transducer on each lift station.

The combination of these technologies produces an intrinsically safe lifting mechanism with immense capacity and high reliability. Chain Jack Shiplift systems built in the 1970’s are still in operation today, none of these systems have ever failed during lifting operations.

References

[1] Taylor, R., (29, April, 2024). Improving Multi-Use Port Facilities Through Key Design Parameters, 35th PIANC World Congress

Relevant UN SDGs (*https://sdgs.un.org/goals*)

7, 8, 9, 12, 13, 14